BIOLOGY

EST, SAT, ACT PREP

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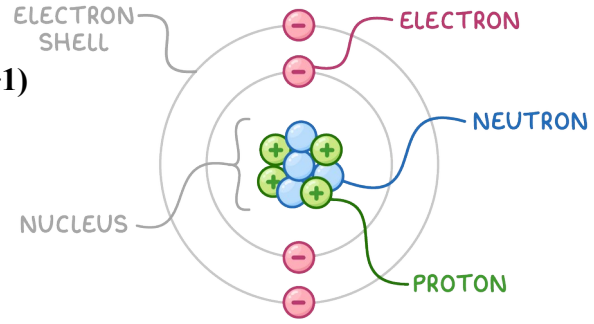
Chapter 2: Biochemistry

The Subatomic particles of the atom:



A. Protons

• Protons are the positively charged particles of the atom (+1)

B. Neutrons

Neutrons have no electric charge

❖Together protons & neutrons form the nucleus of the atom.

The nucleus is at the center of the atom

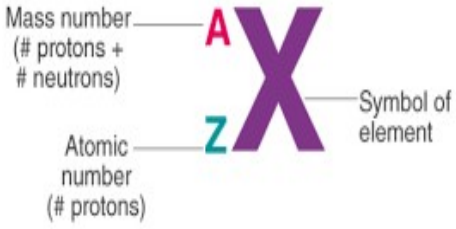
❖The mass of the atom is concentrated in its nucleus

❖ The volume of the nucleus is very small compared to that of the atom

C. Electron cloud

• The negatively charged particles of the atoms are called electrons

• When an atom loses or gains an electron or more, we refer to that atom as an ion



How can we describe atoms?

I. By atomic number:

• The number of **protons** of the nucleus of an atom

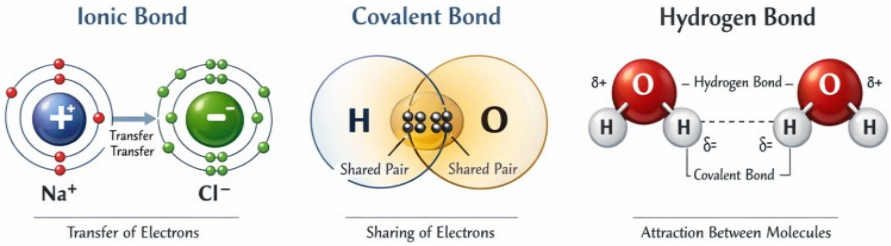
II. By mass number:

• Mass number is the total number of protons & neutrons in atom's nucleus

• The atoms of the same element always have the same number of protons but not always have the same number of neutrons

- Isotopes are atoms of the same element having a **different number of neutrons**.

- Examples: C-12 and C-14.



1) Ionic bond

Transfer electron

2) Covalent bond

• sharing electron

3) Hydrogen bond

• Is formed between hydrogen atom which binds with a polar bond with a high electronegative atom (F, N & O)

• Occurs between molecules

e.g. between water molecules

• Hydrogen bond strength is far weaker than that of covalent bond because the length of hydrogen bond is longer than that of covalent bond

Inorganic Molecules	Organic Molecules
- Existed before life on Earth - May contain carbon atoms - Examples: Water (H2O), Minerals	- Made in cells of living organisms - Must contain carbon atoms - Examples: Carbohydrates, Proteins, Lipids, Vitamins, ATP, DNA

I. Vitamins

- Are organic molecules
- Needed in small amounts
- **Act as co-enzymes**
- Not synthesized in animal cells
- Not digested, but absorbed directly
:

→ **Water soluble:** B & C needed daily

→ **Fat soluble:** K,E,D&A not needed daily, stored in fats

II. Carbohydrates

• General formula: **$C_6H_{12}O_6$** (carbon is most abundant element by weight)

• Fastest & primary source of energy

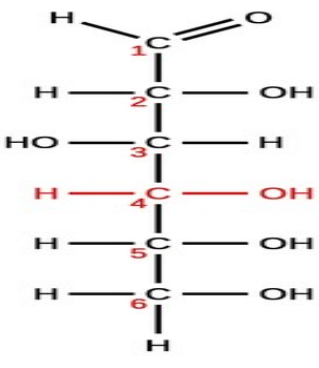
- Composed of Carbon, Hydrogen, and Oxygen (CHO)
- Categories: **Monosaccharides, Disaccharides, and Polysaccharides**

A. Monosaccharide

- Is a monomer (single sugar)
- General formula: C6H12O6
- Examples: **Glucose, fructose, and galactose**
- The arrangement of the molecules makes different monosaccharides
- All monosaccharides are **isomers**

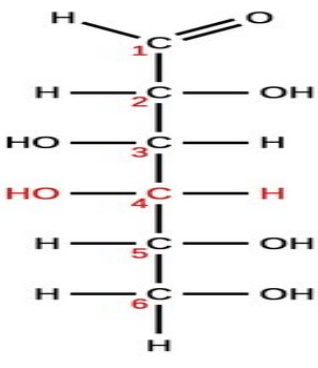
Note: **Isomers** are molecules with the same molecular formula but different structural formulas.

Glucose



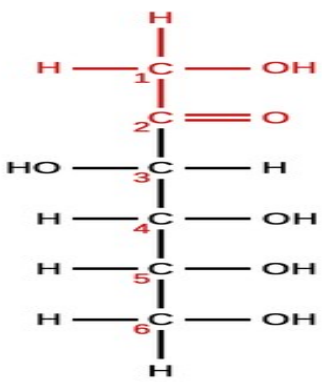
Aldehyde

Galactose



Aldehyde

Fructose



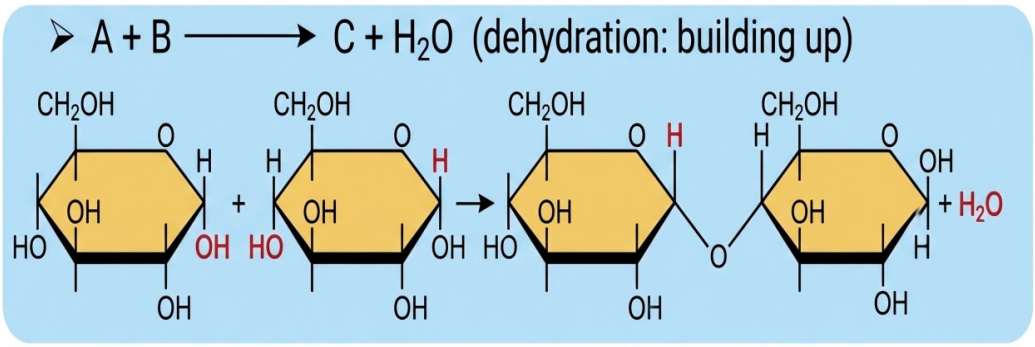
Ketone

B. Disaccharides
Definition: One molecule composed of two units (dimer).

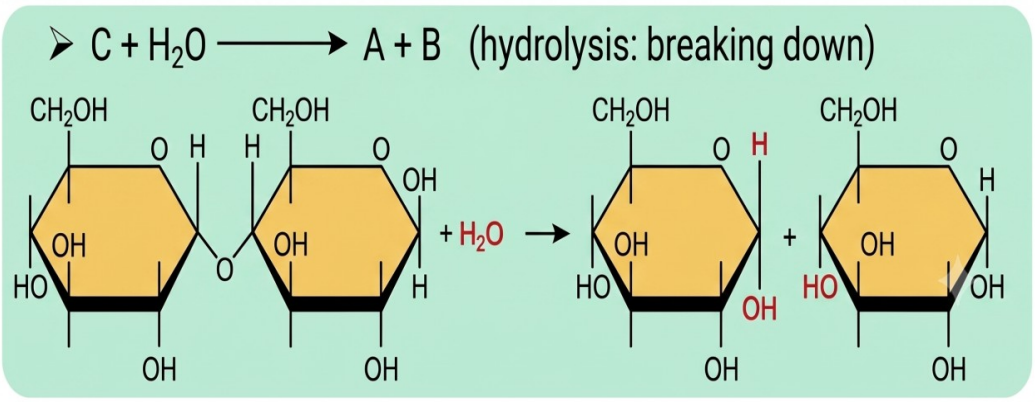
Dehydration Reactions (H2O is the product):
- **Glucose + Glucose -> Maltose + H2O (found in barley or malt)"aldehyde only"**
- **Glucose + Fructose -> Sucrose + H2O (found in fruits))"aldehyde + ketone"**
- **Glucose + Galactose -> Lactose + H2O (found in milk)"aldehyde only"**

Note:

"**polymer from monomer**"



"**monomer from polymer**"



C. Polysaccharide
"One molecule composed of many units (polymer)"

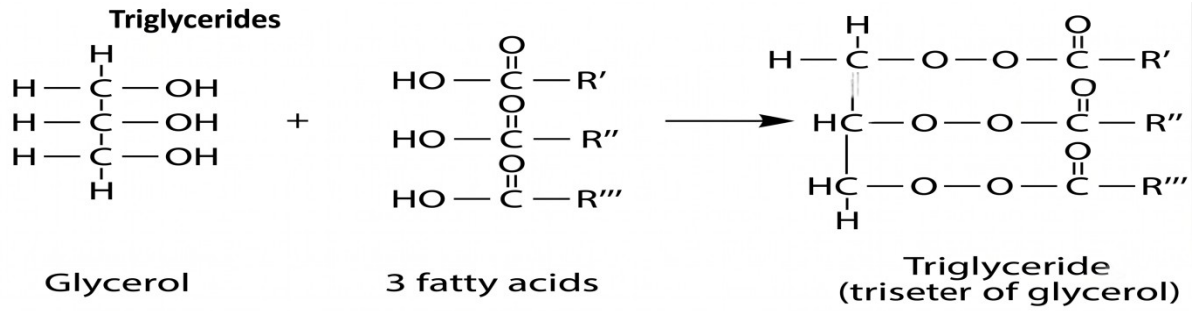
Examples:
- **Starch**: a polysaccharide made in **plant cells** (polymer of glucose)
- **Glycogen**: a polysaccharide made in **animal cells (in liver and muscles**)
- **Chitin**: in the cell **wall of fungi and exoskeleton of arthropods**
- **Cellulose:** in the **cell wall of plant and algae cells**

Note: Not all carbohydrates are used for respiration; some are structural such as cellulose and chitin.

III. Lipids

• Oxygen in lipids is much less than carbon
• Lipids have the highest energy per gram
• Formation of cell membrane (phospholipids)
• **1 g lipid = 9 Kcal, 1 g protein = 4 Kcal, 1 g carb = 4 Kcal**
harder to be broken down than carbohydrates.

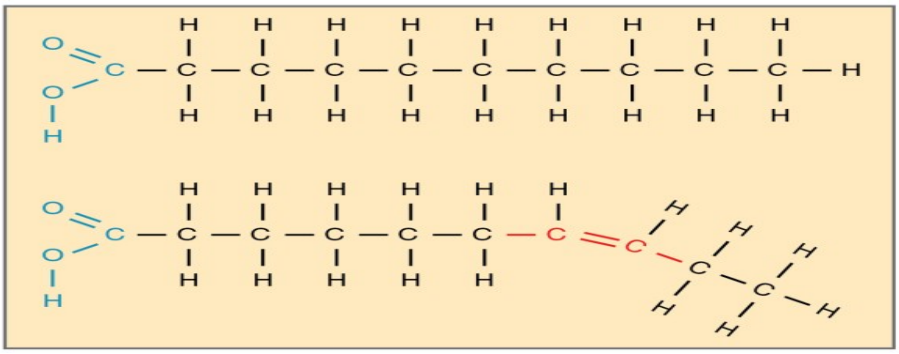
Types of Lipids:
- **Phospholipids** (in cell membranes)
- **Wax(** in ear and on leaves**)**
- **Steroids** (e.g., sex hormones)
- **Triglycerides** (main type)**Glycerol + 3 fatty acids**



Fatty Acids

S.S.S (a) Saturated

(b) Unsaturated

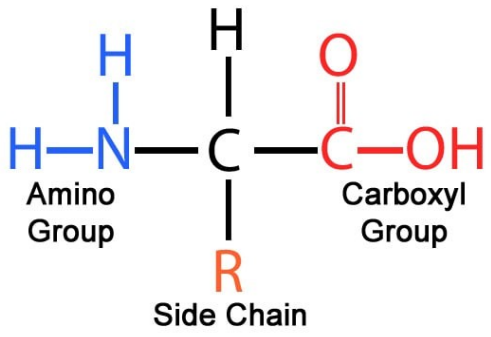


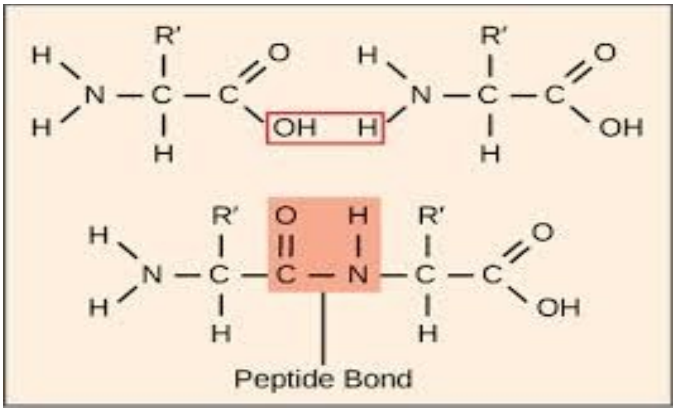
Fats	Oils
• Saturated fatty acids	• Unsaturated fatty acids
• Found in animals	• Found in plants
• Solid at room temperature	• Liquid at room temperature
• Cause heart diseases	• Don't cause heart diseases
Ex: butter & cream & ghee	Ex: coconut oil & olive oil

FUNCTIONS OF LIPIDS
- Storing energy
- Storing fat soluble vitamins
- Thermal insulation
- Buoyancy(الطفو)
- Enters in important compositions: cell membrane, some hormones and myelin sheath in nerve cell
- Cushions organs

IV. Proteins

CHO–N
• Polymer of amino acids (monomer)





NOTE:Amino Acids are 20

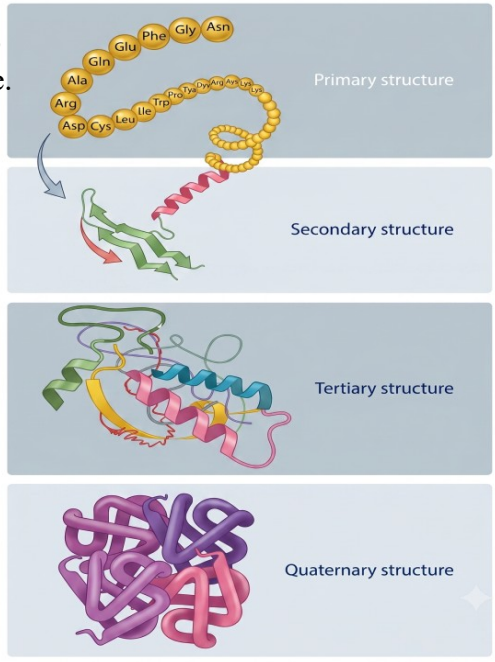
Levels of Proteins

A. Primary structure: a simple molecule made by *several amino acids joined together*; very few proteins are found in this structure.

B. Secondary structure: a coiled form of the primary structure, gives the molecule its **elasticity**.hair, muscles, walls of arteries, and skin
Examples: **collagen & keratin.**

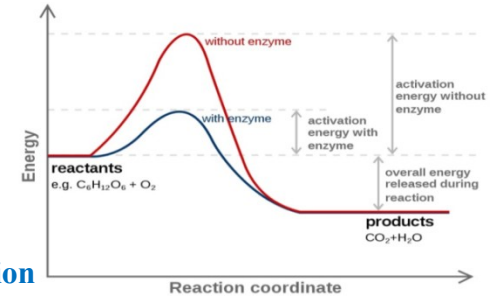
C. Tertiary structure: when the secondary structure is coiled around itself to make a globular shape to fit with something.
Examples: **Enzymes, Hormones & Antibodies.**

D. Quaternary structure: a chain of tertiary structures.
Example: **Hemoglobin**



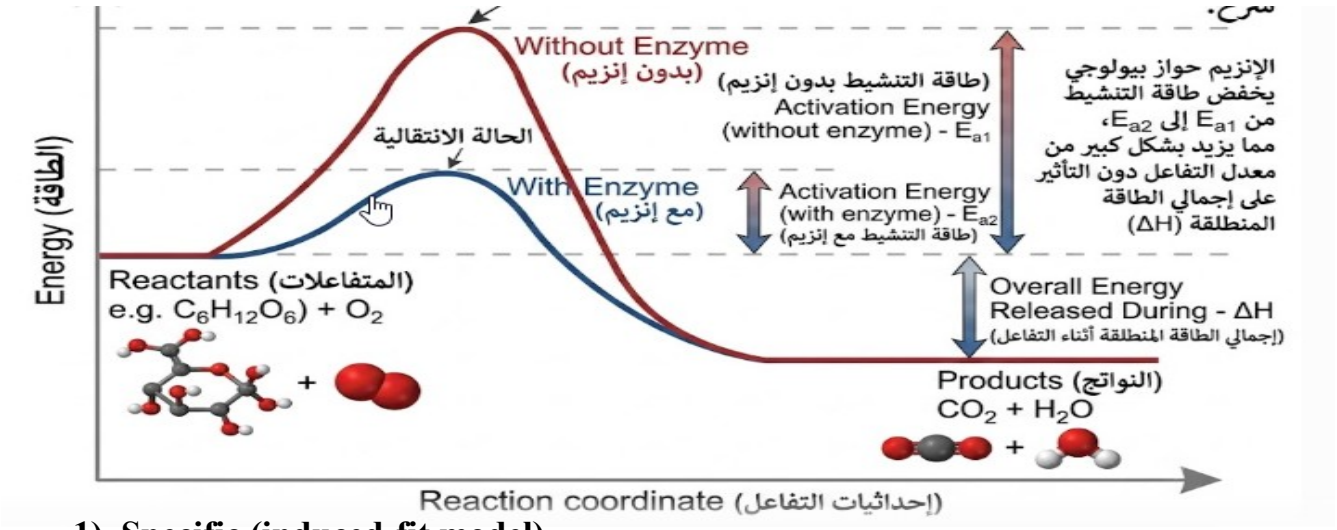
Enzymes (proteins) are catalytic

"A biological **catalyst**, that speeds up the reaction without being involved".

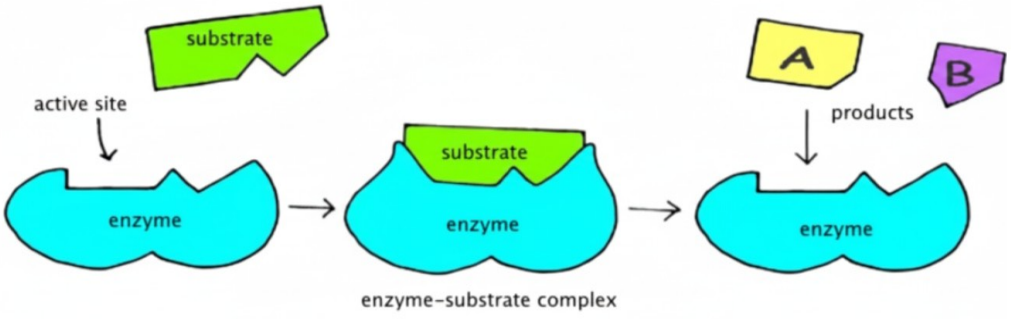


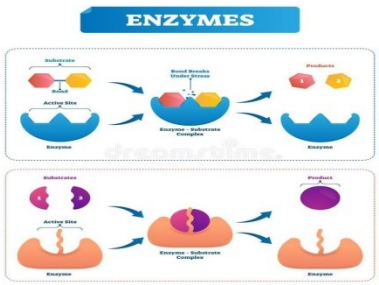
• Any chemical reaction requires activation energy.
• **Activation energy:** the energy needed to start the reaction.
• An enzyme **decreases activation energy**, so that the reaction can take place at body temperature and with a lower energy.
• Activation energy is lower with enzymes.

Note :Enzymes are proteins decrease energy and time of reaction



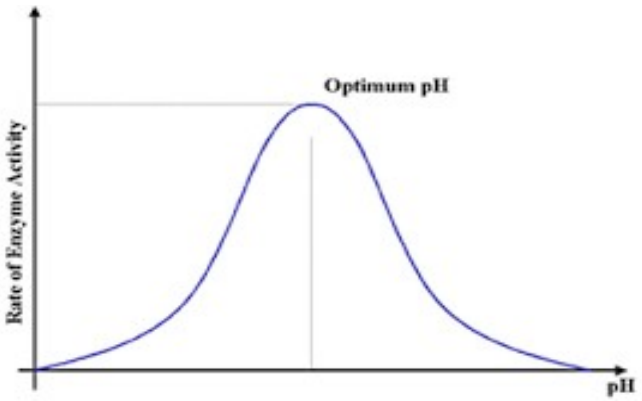
1) Specific (induced-fit model)



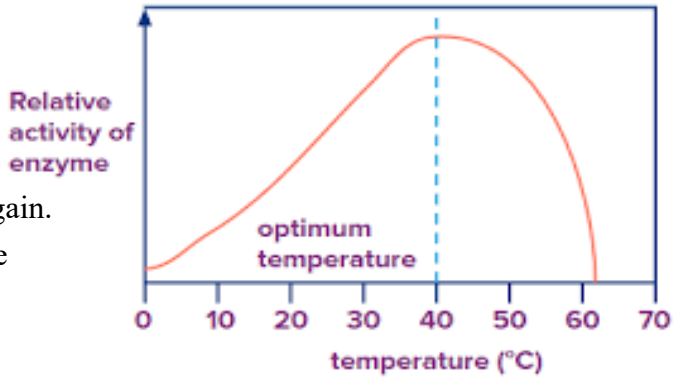


2) Effect of pH:

• Enzymes work at specific pH.
• It becomes **denatured** if placed outside its pH range.



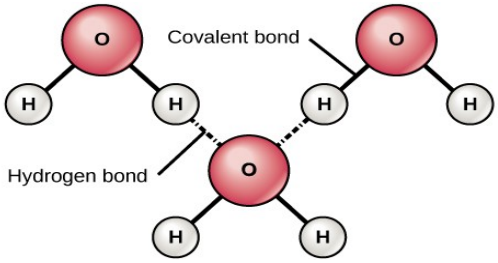
3) Effect of temperature:



✓If placed at a higher temperature than its range, the enzyme becomesdenatured and unfit for work again.

✓ If placed at a lower temperature than its range, the enzyme becomesdeactivated and can work again.

Properties of water



1) Hydrogen bond

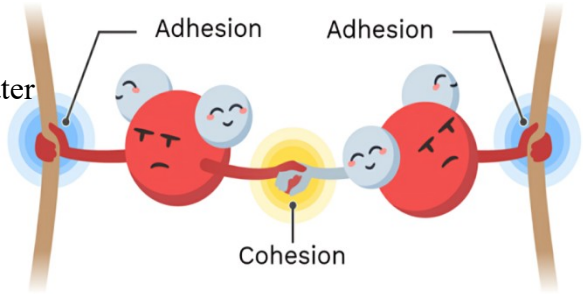
• Oxygen atom in one molecule binds with hydrogen atom in another molecule "between water molecules"

2) Water is cohesive

Cohesion: attraction between similar molecules

• Water molecules bind together

• **Biological benefit:** this property facilitates the ascent of water in xylem vessels against gravity



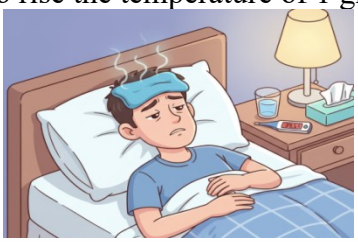
3) Water is adhesive

• Water molecules are attracted to different molecules

❖**Biological benefit:** to keep water held in the xylem and prevent it from falling down

4) Water has high specific heat capacity

• Water needs more amount of heat that must be absorbed in order to rise the temperature of 1 gm of water by 1°C

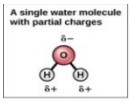


❖**Biological benefit:**

✓ This helps bodies to maintain their body temperature constant

✓ Provides **constant thermal conditions for aquatic organisms**

5) Water has high heat of vaporization



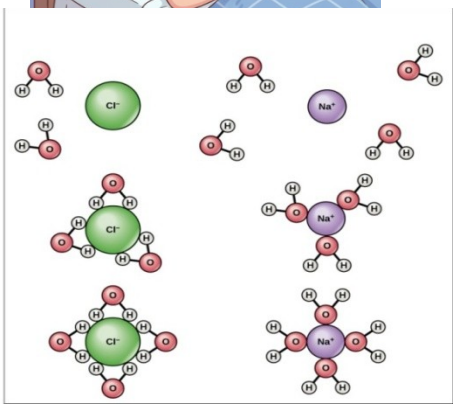
• A relatively great heat is needed to evaporate water

❖**Biological benefit:** water is perfect cooling agent

6) Water is the universal polar solvent

• Because water is a highly polar molecule, it dissolves all polar and ionic substances

❖**Biological benefit:** this frees the ions such that each can participate in its vital role



7) Water has maximum density at 4°C

• Below 4°C, the density of water decreases, so ice floats on the top of the water.

❖**Biological benefit:** so that ice (thermal insulator) and cold water will be on the top of warm water where marine organisms live.

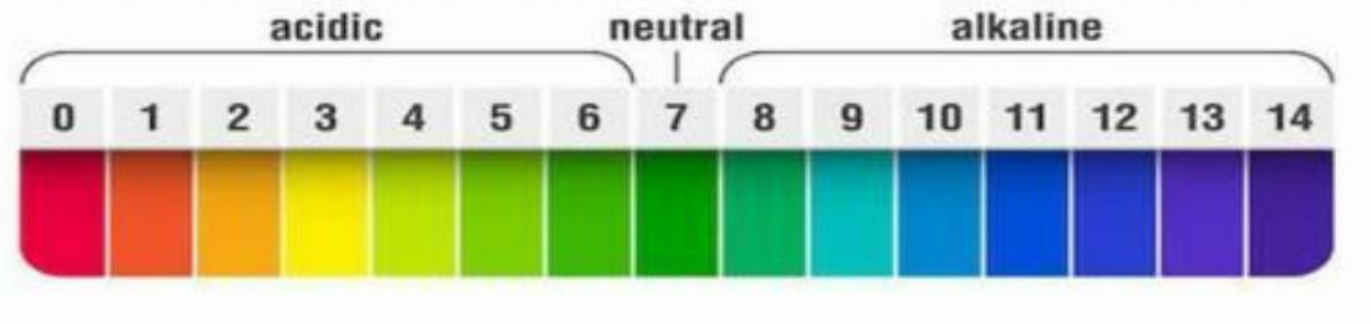
pH

• pH is the negative logarithm of hydrogen ion concentration in mole/liter

• As the concentration of H^+ increases, the pH value decreases

• A solution of pH 1 is 10 times more acidic than that of pH 2 & so on.

Note: Blood PH 7.4



Buffer

• Substance that resists change in pH

• e.g. bicarbonate ion (HCO_3^-)